Winter Use of Large-leafed Privet *Ligustrum lucidum* (Family: Oleaceae) by Birds in Suburban Lismore, New South Wales

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A large proportion of non-sclerophyll forest regrowth in the former "big scrub" region of north-eastern New South Wales is dominated by exotic trees of camphor laurel (*Cinnamomum camphora*) and large-leafed privet (*Ligustrum lucidum*). The high abundances of these species and the widespread clearance of native rainforests has meant that bird species have had to adjust to the new suite of plant resources or be eliminated from the region. The aim of this study was to investigate the variety of birds that use *L. lucidum* during the fruiting season and the ways in which the resources of the privet trees are exploited. The study was conducted in forest stands with a range of relative privet abundances in and around Lismore, in north-eastern New South Wales. A total of 17 species of birds used the privet during this study. Most were frugivores, feeding on the abundant privet fruit, but significantly more insectivory took place at the site with lowest privet abundance. A significant difference was noted in the avifaunal species composition of each site. Privet trees in mixed stands supported a greater range of bird activity and were used by more species than privet trees in near-pure stands. Eradication programs aimed at trees such as privet and camphor laurel will further reduce the resources available to birds and other wildlife unless they are gradual and include replacement with suitable native species.

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INTRODUCTION

Prior to European settlement, forest comprising a mosaic of subtropical rainforest, wet sclerophyll forest, warm temperate and dry rainforest covered more than 75,000 ha in the vicinity of Lismore, north-eastern New South Wales (Holmes 1987; Gosper 1994). These forest types, collectively known as the 'Big Scrub', were cleared in the mid 19th century for agriculture. Native rainforest communities in the region are now limited to small, often isolated remnants and scattered regrowth. The majority of regrowth areas include high proportions of exotic tree species such as camphor laurel (*Cinnamomum camphora*) and large-leafed privet (*Ligustrum lucidum*). These two species are now abundant in the former Big Scrub, often forming mono-specific stands (Gosper 1994). In the absence of native trees, exotic species may provide substantial resources to remaining bird populations (Date et al. 1991).

Ligustrum lucidum, a member of the Oleaceae family, is a shrub or small tree that grows to a height of 10 m and favours a rich, clayey soil (Buchanan 1989a; Harden 1992). *Ligustrum lucidum* is widely distributed from the south coast of New South Wales to north-eastern Queensland. In Northern NSW it is distributed in degraded pasture that once supported rainforest (Anon. 1983; Williams et al. 1984). Fruiting occurs in autumn

and winter, with an average of 400 fruits produced per square metre of canopy (Buchanan 1989a). *Ligustrum lucidum* can produce a total of 100,000 to 10,000,000 seeds on one plant (Westoby et al. 1983; Fox and Adamson 1986; Buchanan 1989a). Of these seeds, 90% are capable of germinating thereby guaranteeing high recruitment of *L. lucidum* in Big Scrub remnants (Dunphy 1991).

The main features of a forest that influence birds are the structure and composition of the vegetation (Ford 1985). These features determine the variety of food types and foraging sites offered by a forest and consequently, the diversity of bird species. The structure of the vegetation also determines the availability of nesting sites and safe refuges from predators (Ford 1985). Bird species diversity is generally higher in rainforest vegetation because it has a greater structural complexity than weedy regrowth areas (MacArthur and MacArthur 1961; Disney and Stokes 1976; Leach and Recher 1993; Gosper 1994).

When environmental weeds invade native vegetation, a shift in the bird species composition can occur (French and Zubovic 1997). Environmental weeds cause changes in food resources and habitat structure, usually resulting in a reduction of the diversity and abundance of bird species (MacArthur and MacArthur 1961). The importance of an introduced plant to birds can increase if it provides more food or cover at a particular place and time than the remaining native vegetation. This is evident in farmland and urban areas where thickets of exotic vegetation can provide the only source of cover for native birds to roost or nest (Loyn and French 1991).

In north-eastern NSW, many birds cannot adjust to the intensively managed agricultural systems that replaced rainforest, so weed dominated regrowth on disused land may constitute an important habitat for their conservation (Gosper 1994). This is particularly evident with frugivorous pigeons in the area, which rely heavily on introduced plant species on farmland during the winter fruiting period (Date et al. 1991). Exotic trees such as *L. lucidum* and *C. camphora* provide an abundance of winter food (Gosper 1994) and act as "stepping stones", facilitating the movement of these species between patches of rainforest (Date et al. 1991). Therefore, the clearing of these exotic plants has the potential to affect the long-term survival of many rainforest birds (Lott and Duggin 1993; Recher et al. 1995).

The aim of this study was to investigate the variety of birds that use *L. lucidum* during the fruiting season and the ways in which the resources of the privet trees are exploited by birds in and around Lismore, north-eastern New South Wales, by examining:

(i) the variation in bird assemblages across four study sites which differ in the proportion of *L. lucidum* in their closed forest communities; and

(ii) the behaviour of birds in *L. lucidum* at four study sites.

METHODS

Study area

The study was conducted in Lismore (28°49′S, 153°16′E) New South Wales, from 20 July to 22 August 1997. Four study sites were selected to represent the range of habitat types in which *L. lucidum* occurs (Fig 1). Sites 1, 3 and 4 were of similar size (4 ha) and were dominated by weed regrowth with high relative abundances of *L. lucidum*. Other weed species at the sites included lantana (*Lantana camara*), wild tobacco (*Solanum mauritianum*) and *C. camphora*. Site 3 had the greatest relative abundance of privet, which in places formed mono-specific stands. Sites 1 and 4 supported a mix of exotic and native dry rainforest trees. Site 4 is close to a large stand of native species dominated by brush box (*Lophostemon confertus*).

Site 2 is Wilson Park Nature Reserve, a 21 ha Big Scrub remnant containing subtropical and dry rainforest vegetation (Holmes 1987). The core of the remnant supports a

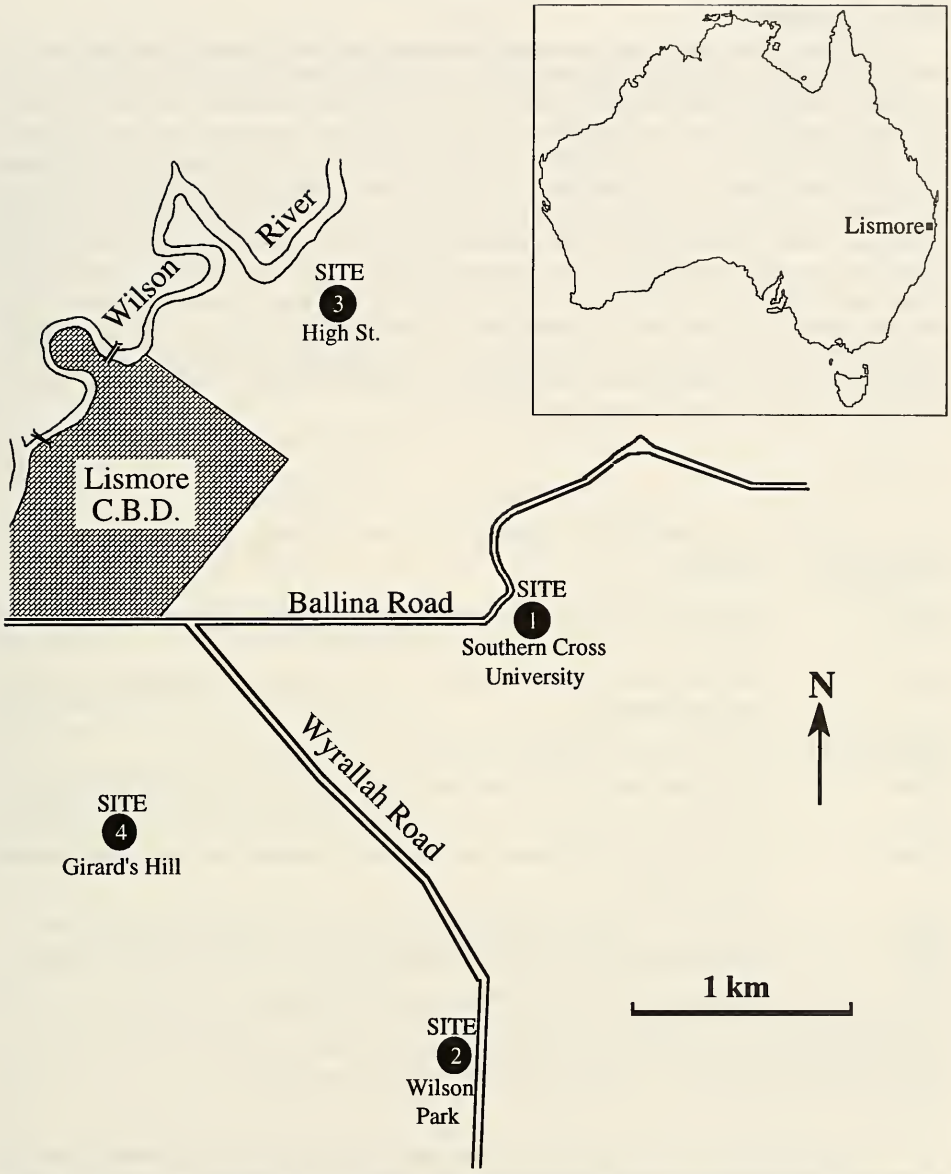

Figure 1. Location of Lismore in North-eastern New South Wales and the locations of the four sites used in relation to the Lismore central business district.

high diversity of native trees and shrubs including forest red-gum (*Eucalyptus tereticornis*), hoop pine (*Araucaria cunninghamii*), python tree (*Austromyrtus bidwillii*), giant water gum (*Syzygium francisii*), whalebone tree (*Streblus brunonianus*) and Moreton bay fig (*Ficus macrophylla*) (Holmes 1987) whilst exotic species *L. lucidum, C. camphora*, climbing asparagus (*Protasparagus africanus*) and *L. camara* are common around the perimeter of the park.

Survey Techniques

The four study sites were surveyed for seven days each, making the total survey period 28 days. On each day observations were conducted for 2–3 hours after sunrise and 2–3 hours prior to sunset. Each site was only surveyed for a maximum of three consecutive days. Sampling was only undertaken on days with little wind and no rain. At each site four sample points were randomly selected within the area of greatest privet abundance and two mature privet trees were selected at each point for observation. The same trees were used for the duration of the study. Observations of both trees at each sample point were made simultaneously over a period of 30 minutes. In this period the behaviour of all bird species using each tree was observed using 8 x 30 mm binoculars from a stationary position approximately 25 m away from the trees. Thus, eight trees at four points were observed for 30 min each morning and afternoon for seven days at each site. Each site therefore received a total of 56 tree-hours of sampling effort over the duration of the study. Behaviour was categorised according to a modified scheme developed by Recher and Holmes (1985) which is summarised in Table 1.

TABLE 1.

Categories of bird behaviour recognised in this study.

Behaviour Type	Description
Perch	any bird which remains stationary on a perch and performs no other behaviour before leaving the *L. lucidum* tree or termination of observation
Call	a bird that makes a vocal noise whilst in *L. lucidum* (may be simultaneously performing any other behaviour)
Feed (Frugivory)	a bird that visits and removes one (or more) fruit from *L. lucidum*
***Glean**	a bird which walks or hops along branches of *L. lucidum*, searching for and taking prey from short distances
***Pounce**	a bird which drops or flies down from a perch in *L. lucidum* to take prey from the ground or low vegetation
***Hover**	a bird in flight remains stationary for brief periods while taking prey from *L. lucidum*
***Probe**	bird extracts from under or within a substrate on *L. lucidum*. e.g. from crevices in bark
*Hawk	bird flies from a perch in *L. lucidum* to take prey (e.g. insect)

* Bird behaviour categories Hawk, Probe, Pounce, Hover and Glean were considered as various forms of insect feeding and were grouped under the heading "Insectivory" for simplicity of analysis.

During any single 30–minute observation period a single behaviour record consisted of one type of behaviour being performed at least once by one or more individuals of a species. It was possible for the same species to display several types of behaviour during the one observation period, thereby generating several records, but multiple displays of the same behaviour type by the same species resulted in a single record for each 30 minute period.

RESULTS

A total of 17 bird species were recorded using privet trees during the study (Table 2). All species were native Australian birds (Slater et al. 1988; Simpson and Day 1996; Pizzey and Knight 1997), and none are considered rare or endangered.

TABLE 2.

Species recorded using privet trees during this study, and their general dietary requirements.

Species[1]	Site 1	Site 2	Site 3	Site 4	Diet[2]
White-headed Pigeon *Columba leucomela*	+				g, f
Varied Triller *Lolage leucomela*				+	g, i, f
Lewin's Honeyeater *Meliphaga lewinii*	+	+		+	g, i, f, n
Silvereye *Zosterops lateralis*	+	+	+	+	g, i, f, n
Figbird *Sphecotheres viridis*	+	+	+	+	g, i, f, h
Pied Currawong *Strepera graculina*	+		+		g, i, f, n
Eastern Yellow Robin *Eospsaltria australis*		+			g, i
Rufous Whistler *Pachycephala rufiventris*	+				g, i, h
Grey Fantail *Rhipidura fuliginosa*		+		+	i
Red-backed Fairy Wren *Maluris melanocephalus*	+				g, i
White-browed Scrubwren *Sericornis frontalis*		+	+		g, i, h
Large-billed Scrubwren *S. magnirostris*		+			i
Brown Gerygone *Gerygone mouki*		+		+	i
Brown Thornbill *Acanthiza pusilla*	+	+	+	+	g, i, n, h
Red-browed Finch *Neochmia temporalis*	+	+			g, i, f
Spangled Drongo *Dicrurus bracteatus*	+			+	i, n
Scarlet Honeyeater *Myzomela sanguinolenta*				+	g, i, n
Total number of species recorded using privet at each site in this study	**10**	**10**	**5**	**9**	

+ Denotes species using privet at this site

[1] Nomenclature from Christidis and Boles (1994)

[2] Feeding types from Barker and Vestjens (1989)

g= granivore; i= insectivore; f= frugivore; n= nectarivore; h= herbivore

The highest number of species was observed at sites 1 and 2 whilst the lowest number of species observed was at site 3. Bird assemblages differed at each site and only three species (brown thornbill, figbird and silvereye) were present at all four sites.

A high percentage of locally nomadic, generalist feeding birds were recorded in *L. lucidum*. A higher number of insectivores were recorded at the native-dominated site (site 2) and one species, large-billed scrubwren, an obligate insectivore, was only recorded at that site. No obligate frugivores were present in the study, although individual rose-crowned fruit-doves (*Ptilinopus regina*) were heard calling from the core of site 2 and small flocks of topknot pigeons (*Lopholaimus antarcticus*) were observed flying over the study area.

A total of 483 behaviour records (200 at site 1; 72 at site 2; 90 at site 3; and 121 at site 4) were noted during 224 tree-hours of survey. Four behaviour categories were observed across the study sites (Fig. 2), these were perching, feeding on privet fruit (frugivory), calling and various forms of insectivory (gleaning, probing, pouncing, and hawking).

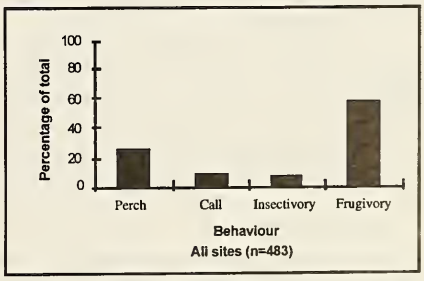

Figure 2. Frequency of each behaviour type as a percentage of total observations (n) across all sites.

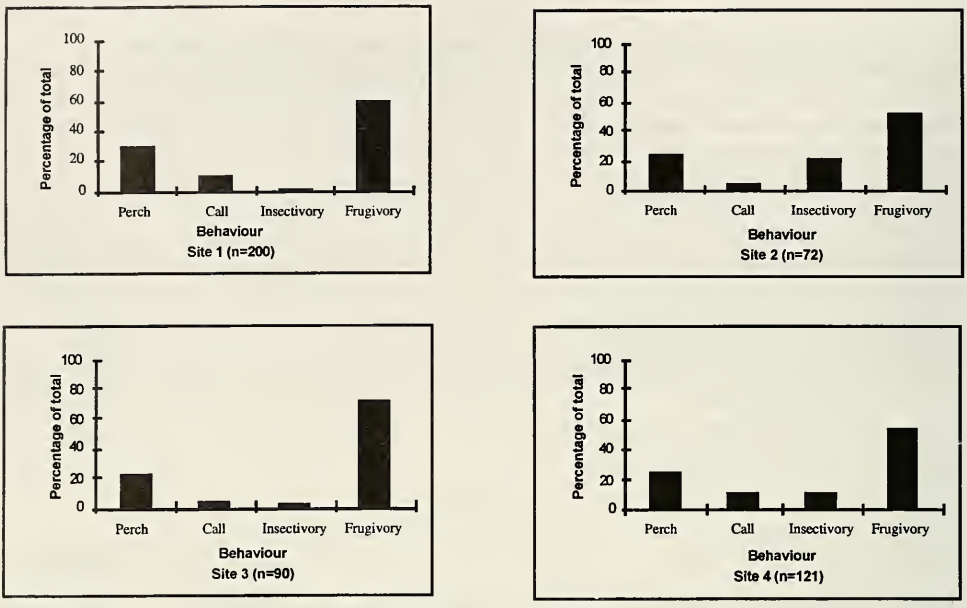

Figure 3. Frequency of each behaviour type as a percentage of total observations (n) across all sites.

Frugivory was the most frequently observed behaviour, followed by perching. The frequencies of observations of calling and insectivory were comparatively low. A *chi*-squared test for heterogeneity of behaviour type shows that bird behaviour when pooled for all species at each site differed significantly across the four study sites ($C^2 = 52.26$, d.f. = 9, P = 0.0001). These differences are illustrated in Fig. 3.

Frugivory was most frequently observed at Site 3, whilst lowest frugivorous activity was at site 2. The most frequent observations of perching was at site 1, whilst the fewest records of perching activity was observed at site 3. Insectivory was most frequently observed at site 2 followed by site 4. A very low frequency of insectivory was recorded at sites 1 and 3.

DISCUSSION

Species Assemblages Across the Study Area

All species recorded in the study are common (Pizzey and Knight 1997). The presence of three species (figbird, silvereye and brown thornbill) across all four study sites may be due, in part, to their generalist feeding and nomadic behaviour (Recher and Holmes 1985) and high population levels in the region (Ekert, pers. obs.).

Figbirds have been recorded to rely heavily on *C. camphora* and *L. lucidum* fruit as a food source in the region during the winter months when native fruit abundance is low (Gosper 1994; Hackett 1997). Their presence across the study area is likely to be related to the availability of *L. lucidum* fruit present at all study sites. Importantly, as the *L. lucidum* fruiting season follows the *C. camphora* fruiting season, the figbirds that are initially attracted by the *C. camphora* fruit may remain when the *L. lucidum* fruit ripens.

Figbirds were commonly found in flocks comprising 10–50 birds. Flocking may enable figbirds to occupy territories and exploit resources by displacing other frugivores.

During this study white-headed pigeons, were forced to leave fruiting privet trees on several occasions by flocking figbirds.

Another species that has been recorded feeding on the fruits of *C. camphora* and *L. lucidum* was the Silvereye (Loyn and French 1991; Gosper 1994; Hackett 1997). In this study silvereyes were frequently observed feeding on *L. lucidum* fruit. Like the figbirds, silvereyes may remain in the area after the *C. camphora* fruiting season to take advantage of *L. lucidum* fruit.

The brown thornbill was another species present across all of the sites. Leach and Recher (1993) and Wood (1996) consider the species to be dependent on remnant vegetation, abundant in both small and large patches of rainforest in N.S.W. However, Gosper (1994) found that this species has broad habitat requirements in north-eastern NSW, enabling it to occur in any forest vegetation, and this seems to be supported by this study.

Privet trees in mixed stands with native plant species (sites 1 and 4) supported a similar number of bird species as privet adjacent to native-dominated remnant rainforest vegetation (site 2). A high percentage of the birds recorded using *L. lucidum* were locally nomadic or migratory within their range (Pizzey and Knight 1997), and the closeness of the study sites may facilitate the movement of these common species between sites. No sedentary bird species were recorded from weed-dominated or mixed forest sites, and the large-billed scrubwren and eastern yellow robin, both sedentary species, were only recorded in site 2. The lowest number of bird species was recorded at the privet-dominated site (site 3). All of them are widespread, generalist feeders (Table 2) and used privet at 3 or 4 of the study sites. This result suggests that isolated, near-pure stands of privet are of limited resource value, however, privet located near native forest provides supplementary resources for many more species.

Fruit pigeons, apart from the one record of a white-headed pigeon at site 1, were absent from *L. lucidum*. Both topknot and white-headed pigeons were observed flying in flocks above the study sites, whilst rose-crowned fruit-doves were heard calling from the core of site 2. There was no trace of other fruit pigeons (wompoo fruit-dove [*P. magnificus*] and superb fruit-dove [*P. superbus*]) that are within their known geographical range (Pizzey and Knight 1997). Their absence may have been due to the aggressive behaviour and dominance of figbirds. More importantly, the small size of the remnants and their isolation from other stands may not provide the amount of fruit nor afford the protection from predators needed for these species (Howe et al. 1981; Innis 1989).

Pied currawongs have been widely documented to incorporate the fruits of exotic species including *L. lucidum* as a major component of their diet, especially during the winter period (Rose 1973; Mulvaney 1986; Buchanan 1989b; Bass 1995, 1996; Wood 1998). During the winter months (non-breeding season), pied currawongs congregate in flocks and migrate from the higher altitudes on the northern tablelands of NSW and the Canberra region into the lower altitudes to take advantage of fruiting exotic plant species (Frith 1969; Bass 1995, 1996).

The few records of pied currawongs feeding on privet in this study are in contrast to other studies in south eastern Australia (Rose 1973; Mulvaney 1986; Buchanan 1989b; Bass 1995, 1996; Wood 1998). Unlike the more temperate regions of Australia, with marked cold and hot seasons and subsequent marked lean and high levels of food resources, the subtropical climate of north eastern NSW may provide pied currawongs with sufficient food resources all year round. This may not necessitate a switch in diet of pied currawongs to fruit and/or a widespread migration to the lower altitudes during the winter period in the region.

Fruiting cycles and food selection

Frugivory was the dominant behaviour of birds at all the study sites, and is likely to be related to the superabundance of fruit at the time of the survey. Similarly, Innis

(1989), Gosper (1994) and Hackett (1997) found that frugivory peaked with the seasonal abundance of fruit. The high percentages of frugivory observations suggest that *L. lucidum* fruit is an important resource for some generalist feeders in the Lismore region. Unlike native members of the Oleaceae Family, *L. lucidum* has the ability to produce an abundance of fruit year after year (Innis 1989). Furthermore, it produces fruit during the lean period of winter and spring when other fruits are comparatively scarce in the region.

Perching appears to be related to the high frequency of feeding records. This is because birds were frequently seen perching before and after taking *L. lucidum* fruit. The perches provided by *L. lucidum* afford birds protection from predators and disturbance from humans. It may also allow frugivores time to process fruit after intense feeding bouts. This underscores the role of *L. lucidum* to act as a local 'stepping stone', facilitating the movement of common birds between fruiting trees.

Insect availability and food selection

A comparative study of spiders in *L. lucidum* and native rainforest remnants in suburban Lismore (S. Burns pers. comm., Southern Cross University), has shown that a greater diversity of spiders exists in native rainforest remnants. The absence of a loose or fissured bark and a low diversity of leaf litter (Amor and Piggin 1977) in *L. lucidum* may reduce the habitat for spiders and insects, thus reducing the availability of food for insectivorous birds. A study of weed-infested coastal vegetation indicated that some specialist leaf litter invertebrates may be strongly affected by such infestations (French and Eardley 1997). This may explain the comparatively low recordings of insectivory in *L. lucidum*, especially in sites 1 and 3, which had the highest relative abundance of privet. Conversely, the presence of fissured bark and a higher plant species diversity of the adjacent plant community at site 2 can provide for a greater diversity of insects and therefore support a greater diversity of insectivorous birds.

Insect availability varies as a direct result of changes in seasons, with insect abundance higher in the warmer months and lower in the cooler months (Ford 1985). This variability may be due to the seasonal flowering of many species rather than changes in temperature, especially in the subtropical climate of northern NSW, and could account for changes in foraging activity of insectivorous birds (Cale 1994). Like the fruit, the flowers of *L. lucidum* are profuse and attract many insects. Flowering of privet had finished prior to commencement of this study and there were few other species in flower during the study period. The lack of abundant flowers would have reduced the potential activity by insects. In addition, there was no opportunity for nectarivorous birds to feed in privet during this study. Further studies incorporating the flowering season of *L. lucidum* are recommended to ascertain the use of privet by insectivorous and nectarivorous birds.

Management Implications

The invasion of exotic species such as *L. lucidum* in areas that once constituted the area of the Big Scrub may be seen as reducing the intrinsic value of native vegetation (Holmes 1987). The supporters of the eradication of this species may need to understand the importance of *L. lucidum* to some native avifauna in the area (Date et al. 1991). With less than 1% of the Big Scrub remaining, *L. lucidum* and *C. camphora* regrowth now occupy large areas of former agricultural land, often providing the only remaining resource for birds. The scarcity of available fruits in the area may further increase if *C. camphora* is declared a noxious weed and removed on a large scale. This may place a greater reliance on *L. lucidum* as an annual food resource by birds in the region.

Eradication of these species would need to be carefully planned to ensure the least disruption to bird feeding patterns. In rural areas, *L. lucidum* regrowth may well be an important habitat and food source for rainforest pigeons. However, the small size of the

study sites and their close proximity to urban areas of Lismore reduce the likelihood of pigeons using the sites in this study. Furthermore, the abundance of territorial and aggressive flocking birds may exclude pigeons from such sites.

Management of *L. lucidum* in Lismore must consider the diversity of avifaunal guilds, including migratory birds that may use *L. lucidum*. This may require retaining *L. lucidum* in the short term with the long-term objective of replacing it with native vegetation (Date et al. 1991). Replacement of *L. lucidum* must be gradual to ensure that the existing resources *L. lucidum* provides to birds are maintained. To adopt a complete eradication of *L. lucidum* without the replanting of native vegetation would further reduce the resources of the region.

The concept of bird conservation may not be compatible with weed control strategies. The conflict involves the provision of a valuable resource to birds, and the dispersal of *L. lucidum* seed. Gradual replacement of *L. lucidum* with native vegetation would mean that there need not be a rapid depletion in fruit availability. However, the continuing presence of mature privet trees results in the dispersal of seeds. This may mean that as areas of *L. lucidum* regrowth are replaced there is still the potential for other sites to be colonised or invaded by *L. lucidum* because of the availability of viable seeds (Loyn and French 1991; Buchanan 1989a).

CONCLUSIONS

The findings of this study suggest that *L. lucidum* provides a resource for a number of common native birds in Lismore. During the winter fruiting season, *L. lucidum* produces an abundance of fruit at a time when the availability of native fruits is comparatively low in the region. This abundance of fruit provides a resource for some generalist frugivores. The dense canopy of *L. lucidum* can afford birds the protection from predators, whilst the close proximity of similar sites in the Lismore area allows such small stands to act as stepping stones thereby facilitating the movement of many species between sites.

The results of this study indicate that privet trees in mixed stands support a greater range of bird activity and are used by more species than privet trees in near-monospecific stands. In particular, sedentary species and insectivores were absent in isolated privet forests. We conclude that eradication programs aimed at trees such as privet and camphor laurel will further reduce the resources available to birds and other wildlife unless they are gradual and include replacement with suitable native species.

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